

Remarks: Claim Amendments

Amendments to the independent claims were made to better clarify the novel features of the invention over the prior art. In particular, the following changes were made:

In the amended Independent Claim 97, the term “— multi-frequency —” was inserted into the third and sixth lines.

In the amended Independent Claim 98, the term “— multi-frequency —” was inserted into the third and fifth lines.

In the amended Independent Claim 99, the term “— multi-frequency —” was inserted into the third and fifth lines.

In the amended Independent Claim 104, the term “— multi-frequency —” was inserted into the third and sixth lines.

In the amended Independent Claim 105, the term “— multi-frequency —” was inserted into the third and sixth lines.

In the amended Independent Claim 106, the term “— multi-frequency —” was inserted into the fourth line.

Remarks: Examination Report

It is submitted that with the amended claims herein, the objections raised against the claims are overcome.

1. Section 1 of the Examination Report

The Office Action is in response to the office letter filed on 10/28/2003 and is non-final.

2. Section 2 of the Examination Report

The previous rejection of claims 44-136 under 35 USC 102(e) has been withdrawn. However, new grounds for rejection are made in view of additional prior art.

3. Section 3 of the Examination Report

Claims 82, 87, 97-99, and 104-106 were rejected under 35 U.S.C. 102(b) as being anticipated by Hamalainen, et. al. (U.S. Pat. No. 5,815,801).

4. With regard to Independent Claim 82 and Dependent Claim 87, Applicant submits that the above-recited combiner (62mn) capable of combining the plurality of received **multi-frequency** carrier-signal components with respect to the at least one phase space to produce at least one constructive interference signal indicative of at least one information signal recited in Independent Claim 82 (and hence, in the dependent claim 87) clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the Independent Claim 82 (and hence, the dependent claim 87) should be considered patentable under 35 U.S.C. 102.
5. With regard to the amended Independent Claim 97, the steps of providing for selecting a plurality of received **multi-frequency** carriers within a predetermined bandwidth; providing for generating at least one pulse waveform from a superposition of the selected **multi-frequency** carriers clearly presents a novel method that the prior-art references neither describe nor anticipate. Thus, the amended Independent Claim 97 should be considered patentable under 35 U.S.C. 102.

6. With regard to the amended Independent Claim 98, Applicant submits that the above-recited a combiner coupled to the filter, the combiner adapted to combine the received **multi-frequency** carriers to produce at least one signal indicative of a modulated pulse waveform clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the amended Independent Claim 98 should be considered patentable under 35 U.S.C. 102.
7. With regard to the amended Independent Claim 99, Applicant submits that the above-recited combiner adapted to optimally combine the received **multi-frequency** carriers in the presence of at least one of interference and multipath to generate at least one signal indicative of a modulated pulse waveform clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the amended Independent Claim 99 should be considered patentable under 35 U.S.C. 102.
8. With regard to the amended Independent Claim 104, the steps of providing for generating at least one pulse waveform from a superposition of the selected **multi-frequency** carriers; and providing for estimating at least one information symbol impressed on the at least one of the pulse waveforms clearly presents a novel method that the prior-art references neither describe nor anticipate. Thus, the amended Independent Claim 104 should be considered patentable under 35 U.S.C. 102.
9. With regard to the amended Independent Claim 105, the pulse generator adapted to produce at least one pulse waveform from a superposition of selected **multi-frequency** carriers; and the modulator coupled to the pulse generator, the modulator adapted to accept at least one information symbol and impress the at least one information symbol onto the at least one pulse waveform clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the amended Independent Claim 105 should be considered patentable under 35 U.S.C. 102.

With regard to the amended Independent Claim 106, the pulse generator adapted to produce at least one pulse waveform having a plurality of **multi-frequency carrier** components; and the modulator coupled to the pulse generator, the modulator adapted to accept at least one information symbol and impress the at least one information symbol on the at least one pulse waveform clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the amended Independent Claim 106 should be considered patentable under 35 U.S.C. 102.

10. Specifically, the claimed invention combines a plurality of **multi-frequency carriers** to generate pulse waveforms which are then advantageously used to convey information. By generating pulse waveforms in this manner, Applicant's invention enables each data symbol to be spread over multiple carriers, thus providing superior frequency diversity. Furthermore, these pulse waveforms provide orthogonality in time, which enables multiple data symbols and/or users to share the same frequencies, thus providing combined, and typically contradictory, benefits of frequency diversity and bandwidth efficiency. No other prior-art reference deliberately produces pulse waveforms from superpositions of multi-frequency carriers. No other prior-art reference produces pulse waveforms from a superposition of multi-frequency carriers in such a way as to spread information across the carriers, and thus provide contradictory benefits of frequency diversity and bandwidth efficiency.
11. None of the prior-art references teach to generate pulse waveforms by **combining multi-frequency carrier signals (or producing a pulse waveform from a superposition of selected multi-frequency carriers)**, such as recited in Independent Claims 82, 97-99, and 104-106. None of the prior-art references teach receiver techniques for combining multi-frequency carriers in a way that produces pulses because none of the prior-art references teach to encode a multicarrier signal with phase spaces that map data symbols to pulse waveforms generated from multi-frequency carrier superpositions. Such superpositions are unique to Applicant's invention of Carrier Interferometry (CIMA) waveforms.

Hamalainen (U.S. Pat. No. 5,815,801) discloses a method whereby a **single-carrier** pilot signal is transmitted by each of a plurality of CDMA base stations. Each pilot signal comprises the same pseudo-noise sequence. However, each base station transmits the pilot signal with a given time (i.e., phase) offset. A receiver (i.e., a subscriber terminal) employs a cross correlator to synchronize with the received pilot signals. A maximum correlation value corresponds to a particular time (i.e., phase) offset, which identifies the base station providing the strongest signal at the receiver. The mobile terminal then synchronizes to the strongest pilot signal. Signal levels from other base stations are regarded as interference, and this training technique is used as a first step for determining interference levels in a multi-user detector. The Rake receiver described by Hamalainen (col. 5, lines 39-45) is well known in DS-CDMA systems, and it functions as a set of delay taps that are used to combine multiple delayed (e.g., reflected) versions of a given received signal. The signals received by the Rake are **single-carrier** signals rather than **multi-frequency** signals. Therefore, combining the Rake signals does not result in a pulse waveform.

Accordingly, Hamalainen's system is not capable of providing the benefits of the present invention, including diversity across multi-frequency signals and improved bandwidth efficiency in a multicarrier system. Therefore, it will be appreciated therefore that the schema described by the cited art is not the same as that claimed by the present invention. The present claims are therefore novel.

12. The claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

13. As detailed above, the cited art describes a different type of receiver system to that claimed by the present invention. Although different to the present invention, such receivers have use, as is evidenced by the teaching of the prior art. Such use is served by the Rake receiver and there is no teaching in the prior art to change the type of communication protocol provided so as to resemble or reflect that of the present invention. Furthermore, in-phase combining of multi-frequency signals is taught

against by the relevant art because, unlike in the present invention, the resulting peak-to-average power becomes very high. As there is no motivation to change, no teaching to change, and no description of how any change may be made to produce a CIMA receiver, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

14. Section 4 of the Examination Report

Claims 95, 100, 110, and 111 were rejected under 35 U.S.C. 102(e) as being anticipated by Awater, et. al. (U.S. Pat. No. 6,175,551).

15. Applicant submits that the above-recited steps of performing a frequency domain to time domain transform operation on the filtered frequency-domain signal to generate a filtered time-domain signal and **recovering symbols transmitted to the at least one user from the filtered time-domain signal** in Independent Claim 95 (and hence, in the Dependent Claim 120) clearly presents novel methods for processing a **received** multi-carrier signal that the prior-art references neither describe nor anticipate. Thus, the Independent Claim 95 (and hence, the Dependent Claim 120) should be considered patentable under 35 U.S.C. 102.

16. Applicant submits that in the above-recited frequency to time domain transform module adapted to perform a frequency domain to time domain transform operation on the filtered frequency-domain signal to thereby generate a time-domain signal; and a **decision module for mapping received signal values at points in time to estimated symbol values** in Independent Claim 100 (and hence, in the dependent claim 125) clearly presents novel receiver structure for processing a plurality of carriers that the prior-art references neither describe nor anticipate. Thus, the Independent Claim 100 (and hence, the Dependent Claim 125) should be considered patentable under 35 U.S.C. 102.

17. In particular, the claimed invention in Independent Claims 95 and 100 pertains to a **reception method** and a **receiver**. In a receiver, the steps of performing a frequency domain to time domain transform operation to generate a filtered time-domain signal and **recovering symbols from the filtered time-domain signal** are unique to the present invention because no prior-art multicarrier signaling protocol allows information (i.e., symbols) to be recovered from a time-domain representation of the multicarrier signal. Rather, all prior-art multicarrier signals need to be converted to the frequency domain before information can be recovered. Thus, providing for a frequency domain to time domain transformation of a multicarrier signal as a precursor to recovering information in a receiver is not taught in the prior art. This is because it is impractical to process prior-art multicarrier signals in that manner. Similarly, a receiver having a frequency domain to time domain transform followed by a decision module for mapping received signal values at points in time to estimated symbol values is not anticipated by the prior art because such structure would not be practical for receiving prior-art multicarrier waveforms.

18. None of the prior-art references teach to implement a receiver that performs a frequency domain to time domain transform of a multicarrier signal followed by recovering information from the resulting time-domain signal. None of the prior-art references teach to transform a multicarrier signal into a signal having time-domain characteristics indicative of data symbols mapped to instants in time.

This is because only signals generated via Carrier Interferometry produce highly orthogonal, data-bearing pulses in the time domain. Prior-art multicarrier signals, such as shown in Awater, modulate different data symbols on each carrier or spread data across carriers with spreading codes that do not support orthogonality in the time domain.

Awater shows a **transmitter and transmission method** rather than a **receiver and receiver method**. Awater discloses means for reducing the peak-to-average power

ratio (PAPR) of prior-art multicarrier signals by employing cancellation signals for canceling peaks in the aggregate time-domain multicarrier signal. In figure 4, a filter block 56 restricts the spectrum of impulses used to cancel peaks in the information-modulated multicarrier signal. This ensures that the non-information bearing cancellation impulses do not exceed the bandwidth of the multicarrier signal. Although the signal output from the Awater transmitter is a time-domain signal, Awater suggests that the corresponding receiver should be a standard OFDM receiver (col. 4, lines 24-26), which generates a frequency-domain signal, rather than a time-domain signal in order to recover the transmitted information.

The prior art does not suggest any combination or application of the filter block 56 shown in figure 4 to multicarrier receivers or reception methods. The nature of prior-art multicarrier signals makes it impractical to apply Awater's filter block 56 to multicarrier receivers. This is because in prior-art multicarrier signals, data symbols are not mapped to instants in time. Superposition pulses resulting from prior-art multicarrier signals comprise interfering data symbols at instants in time, such as illustrated and described in Applicant's U.S. Pat. No. 5,955,992, of which the present application is a Continuation in Part. Thus, it would not be appropriate to process prior-art multicarrier signals in the manner claimed by the present invention. Conversely, the relied-upon prior-art reference Awater states that a standard OFDM receiver should be employed (col. 4, lines 24-26).

19. Applicant submits that the above-recited data source (which is adapted to process a plurality of information symbols to generate a set of data symbols with a predetermined set of phase relationships and amplitude profiles to **provide a superposition of the carriers with orthogonality in time**) in both Independent Claims 110 and 111 (and hence, in the Dependent Claims 135 and 136) presents novel structure that the prior-art references neither describe nor anticipate. Thus, the Independent Claims 110 and 111 (and hence, the Dependent Claims 135 and 136) should be considered patentable under 35 U.S.C. 102.

20. Specifically, by providing a plurality of data symbols with a predetermined set of phase relationships and amplitude profiles that provide a superposition of the carriers with orthogonality in time, each data symbol is spread over the carriers (thus providing frequency diversity) and **the data symbols are mapped onto orthogonal pulse waveforms** (thus providing optimal bandwidth efficiency). Furthermore, this results in a multicarrier signal having a **very low Peak-to-Average Power**.

21. **None of the prior-art references teach to transform a multicarrier signal into a signal having time-domain characteristics indicative of data symbols mapped to instants in time. None of the prior-art references teach to generate a set of data symbols with a predetermined set of phase relationships and amplitude profiles to provide a superposition of the carriers with orthogonality in time.**

Awater discloses means for reducing the peak-to-average power ratio of prior-art multicarrier signals, **which do not map data symbols to instants in time**. While Awater does show impulses, these impulses are employed as cancellation signals to cancel peaks in the aggregate time-domain multicarrier signal. These impulses do not convey data. Peaks occur in prior-art multicarrier signals because different data symbols modulated onto different carriers cause unexpected superposition spikes to occur. **These spikes result from undesirable phase alignments between the data-modulated subcarriers**. In figure 4, a filter block 56 restricts the spectrum of impulses used to cancel peaks in the information-modulated multicarrier signal. This ensures that the non-information bearing cancellation impulses do not exceed the bandwidth of the multicarrier signal. Awater's peak-cancellation **does not map data symbols to instants in time**. The resulting canceled multicarrier signal is **not characterized by carrier superpositions having orthogonality in time**. Rather, Awater processes signals that are orthogonal in frequency (col. 1, lines 7-14).

The prior art does not suggest any variation of Awater that . The nature of prior-art multicarrier signals makes it impractical to apply Awater's filter block 56 to multicarrier receivers. This is because in prior-art multicarrier signals, data symbols

are not mapped to instants in time. Superposition pulses resulting from prior-art multicarrier signals comprise interfering data symbols at instants in time, such as illustrated and described in Applicant's U.S. Pat. No. 5,955,992, of which the present application is a Continuation in Part. Thus, it would not be appropriate to process prior-art multicarrier signals in the manner claimed by the present invention. Conversely, the relied-upon prior-art reference Awater states that a standard OFDM receiver should be employed (col. 4, lines 24-26).

22. The claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

23. As detailed above, the cited art describes a different type of transmission system to that claimed by the present invention. Although different to the present invention, such transmission systems have use with respect to prior-art multicarrier signaling, as is evidenced by the teaching of the prior art. Such use is served by Awater's transmitter and there is no teaching in the prior art to change the type of transmitter provided so as to resemble or reflect that of the present invention. Furthermore, in-phase combining of multi-frequency signals is taught against by the relevant art. For example, Awater's cancellation system is designed to cancel undesirable peaks resulting from in-phase combining of the carriers. Unlike in the present invention, in-phase combining of a multicarrier signal results in a high peak-to-average power. As there is no motivation to change, no teaching to change, and no description of how any change may be made to produce a CIMA transmitter, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

24. The Present Invention Eliminates the Need for the Invention Disclosed in the Cited and Relied-Up Reference, Awater.

25. Of particular relevance to the cited and relied upon reference, Awater, the present invention maps data onto orthogonal pulse waveforms, which are sequentially

positioned in time. The resulting data-modulated pulse sequence is a multicarrier signal that has low Peak-to-Average Power like a single-carrier signal. This reduces or eliminates the need for the peak-cancellation system disclosed by Awater if CIMA signals are employed.

26. Section 5 of the Examination Report

Claims 88, 93, 94, 96, and 101 were rejected under 35 U.S.C. 103(a) as being unpatentable over Hamalainen, et. al. (U.S. Pat. No. 5,815,801) in view of Odenwalder (US 2002/0009096).

27. With regard to Dependent Claim 88, Applicant submits that the above-recited combiner (62mn) capable of combining the plurality of received **multi-frequency** carrier-signal components with respect to the at least one phase space to produce at least one constructive interference signal indicative of at least one information signal recited in Independent Claim 82 (and hence, in the dependent claim 88) clearly presents novel structure that is non-obvious in view of the prior-art references. Thus, the Independent Claim 82 (and hence, the Dependent Claim 88) should be considered patentable under 35 U.S.C. 103.

28. In particular, the combiner recited in the Independent Claim 82 combines the carriers with respect to at least one phase space to produce at least one constructive interference signal (i.e., pulse) indicative of at least one information signal. This novel functionality represents a technique whose principles are taught against in the art, but leads to new and unexpected performance benefits, which should be patentable under 35 U.S.C. 103.

29. The claimed invention produces constructive interference signals (e.g., data-modulated pulses) from multicarrier signals, which no prior-art references nor combination of prior-art references disclose. New and unexpected benefits are created, making the claimed invention non-obvious. For example, reduced complexity

of multicarrier receiver designs are enabled, backwards compatibility with existing single-carrier signals is possible, and simultaneous benefits of optimal bandwidth efficiency and frequency diversity are achieved, which greatly improves performance.

30. As detailed above, the cited art describes a different type of receiver system to that claimed by the present invention. For example, Hamalainen's receiver includes a Rake for combining **same-frequency single-carrier** signals rather than **multi-frequency** signals. Although different to the present invention, such receivers have use, as is evidenced by the teaching of the prior art. Such use is served by the Rake receiver and there is no teaching in the prior art to change the type of communication protocol provided so as to resemble or reflect that of the present invention. Also, there is no suggestion in the prior art to combine Hamalainen and Odenwalder in such a way as to produce a constructive interference signal (i.e., pulse) indicative of at least one information signal.
31. **Further reasons suggest that the invention is non-obvious and worthy of patent protection.** For example, in-phase combining of multi-frequency signals is **taught against by the relevant art** because, unlike in the present invention, the resulting peak-to-average power of multicarrier signals becomes very high. Rather, the present invention deliberately generates constructive-interference pulses (which have the highest possible peak-to-average power) from multicarrier signals and then positions the pulses orthogonally in time, resulting in an aggregate signal having very low peak-to-average power. Accordingly, the present invention **solves an important and recognized problem in the art** of multicarrier signaling by implementing in-phase combining, which is clearly **taught against by the prior art**. The claimed receiver of the present invention pertains to processing CIMA signals, which are significantly different than all prior-art multicarrier signals. Since conventional multicarrier receivers do not provide an optimal solution for receiving CIMA signals, the present invention **solves a different problem** than prior-art multicarrier receivers. As there is no motivation to change, no teaching to change, and no description of how any change may be made to produce a CIMA receiver, it is submitted that the presently

claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

32. Applicant submits that the above-recited phase-space controller and combiner in the Independent Claim 93 (and hence, in the Dependent Claim 94) clearly presents novel structure that is non-obvious in view of the prior-art references. Thus, the Independent Claim 93 (and hence, the Dependent Claim 94) should be considered patentable under 35 U.S.C. 103.
33. Applicant submits that the above-recited step of providing for mapping values of the multicarrier signal after channel compensation at instants in time used to transmit symbol values in the Independent Claim 96 clearly presents a novel method that is non-obvious in view of the prior-art references. Thus, the Independent Claim 96 should be considered patentable under 35 U.S.C. 103.
34. Applicant submits that the above-recited decision module adapted to map values of the multicarrier signal after channel compensation at instants in time used to transmit symbol values in the Independent Claim 101 clearly presents novel structure that is non-obvious in view of the prior-art references. Thus, the Independent Claim 101 should be considered patentable under 35 U.S.C. 103.
35. In particular, the phase-space controller provides incremental phase offsets to the carrier signals for providing the carrier signals with a predetermined phase space at a predetermined time interval, and the combiner combines the modulated, phased carriers to produce a spread-spectrum signal from a superposition of the carrier signals. A phase space characterizes where data is mapped to (e.g., impressed on) one or more pulse waveforms centered at one or more particular instant(s) in time. The phase space characterizes a constructive superposition of the multicarrier signal to produce one or more pulses. Thus, the phase-space controller and the combiner map values of the multicarrier signal to instants in time used to transmit symbol values.

36. No other prior-art reference (or combination of prior-art references) uses phase spaces, which map data symbols to instants in time. In fact, the deliberate generation of phase spaces resulting in pulses with high peak-to-average power are explicitly **taught against by the prior art**. The claimed invention produces constructive interference signals (e.g., data-modulated pulses) from multicarrier signals, which no prior-art references nor combination of prior-art references disclose. **New and unexpected benefits** are created, making the claimed invention non-obvious. For example, reduced complexity of multicarrier receiver designs are enabled, backwards compatibility with existing single-carrier signals is possible, and simultaneous benefits of optimal bandwidth efficiency and frequency diversity are achieved, which greatly improves performance. Alternatively, Hamalainen's receiver includes a Rake for combining single-frequency, single-carrier signals rather than multi-frequency signals. Although different to the present invention, such receivers have use, as is evidenced by the teaching of the prior art. Such use is served by the Rake receiver and there is no teaching in the prior art to change the type of Rake combiner provided so as to resemble or reflect that of the present invention. Also, there is no suggestion in the prior art to combine Hamalainen and Odenwalder in such a way as to produce a constructive interference signal (i.e., pulse waveforms) or phase spaces for mapping data to instants in time. Furthermore, in-phase combining of multi-frequency signals is **taught against by the relevant art** because, unlike in the present invention, the resulting peak-to-average power becomes very high. The present invention is characterized by a sequence, or stream, of pulses that result in an overall low peak-to-average power, which is truly an **unanticipated and unexpected consequence** in view of the current teaching in the art. As there is no teaching to change, and no description of how any change may be made to map values of a multicarrier signal to instants in time used to transmit symbol values, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

37. Section 6 of the Examination Report

Claims 119, 121, and 126 were rejected under 35 U.S.C. 103(a) as being unpatentable over Hamalainen, et. al. (U.S. Pat. No. 5,815,801) in view of Odenwalder (US 2002/0009096) further in view of Dent, et. al. (U.S. Pat. No. 5,931,893).

38. Claims 119, 121, and 126 are Dependent Claims of Independent Claims 93, 96, and 101, respectively. The Independent Claims 93, 96, and 101 (and thus, the Dependent Claims 119, 121, and 126) should be considered non-obvious, and thus, patentable under 35 U.S.C. 103.
39. In particular, the phase-space controller (recited in Claim 93) provides incremental phase offsets to the carrier signals for providing the carrier signals with a predetermined phase space at a predetermined time interval, and the combiner (also recited in Claim 93) combines the modulated, phased carriers to produce a spread-spectrum signal from a superposition of the carrier signals. A phase space characterizes where data is mapped to (e.g., impressed on) one or more pulse waveforms centered at one or more particular instant(s) in time. The phase space characterizes a constructive superposition of the multicarrier signal to produce one or more pulses. Thus, the phase-space controller and the combiner map values of the multicarrier signal to instants in time used to transmit symbol values, such as recited in Claims 96 and 101. None of the prior-art references (nor any combination of the prior-art references) teaches to provide at least one phase space to a multicarrier signal.
40. No other prior-art reference (or combination of prior-art references) uses phase spaces, which map data symbols to instants in time. In fact, the deliberate generation of phase spaces resulting in pulses with high peak-to-average power are explicitly **taught against by the prior art**. The claimed invention produces constructive interference signals (e.g., data-modulated pulses) from multicarrier signals, which no prior-art references nor combination of prior-art references disclose. **New and unexpected benefits** are created, making the claimed invention non-obvious. For example, reduced complexity of multicarrier receiver designs are enabled, backwards

compatibility with existing single-carrier signals is possible, and simultaneous benefits of optimal bandwidth efficiency and frequency diversity are achieved, which greatly improves performance. Alternatively, Hamalainen's receiver includes a Rake for combining single-frequency, single-carrier signals rather than multi-frequency signals. Although different to the present invention, such receivers have use, as is evidenced by the teaching of the prior art. Such use is served by the Rake receiver and there is no teaching in the prior art to change the type of combiner or combining method provided so as to resemble or reflect that of the present invention. Also, there is no suggestion in the prior art to combine Hamalainen, Odenwalder, and Dent in such a way as to produce a constructive interference signal (i.e., pulse waveforms) or phase spaces in a multicarrier signal for mapping data to instants in time. Furthermore, in-phase combining of multicarrier signals is **taught against by the relevant art** because, unlike in the present invention, the resulting peak-to-average power becomes very high. The present invention is characterized by a sequence, or stream, of pulses that result in an overall low peak-to-average power, which is truly an **unanticipated and unexpected consequence** in view of the current teaching in the art. As there is no teaching to change, and no description of how any change may be made to map values of a multicarrier signal to instants in time used to transmit symbol values, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

41. Section 7 of the Examination Report

Claims 120, 125, 135, and 136 were rejected under 35 U.S.C. 102(e) as being anticipated by Awater, et. al. (U.S. Pat. No. 6,175,551) in view of Dent, et. al. (U.S. Pat. No. 5,931,893).

42. Claims 120, 125, 135, and 136 are Dependent Claims of Independent Claims 95, 100, 110, and 111, respectively. The Independent Claims 95, 100, 110, and 111 (and thus, the Dependent Claims 120, 125, 135, and 136) should be considered non-obvious, and thus, patentable under 35 U.S.C. 103.

43. **The Independent Claims 95 and 100 (and thus, the corresponding Dependent Claims 120 and 125) should be considered patentable under 35 U.S.C. 103.**
44. Applicant submits that the above-recited steps of performing a frequency domain to time domain transform operation on the filtered frequency-domain signal to generate a filtered time-domain signal and **recovering symbols transmitted to the at least one user from the filtered time-domain signal** in Independent Claim 95 (and hence, in the Dependent Claim 120) clearly presents novel methods for processing a received multi-carrier signal that the prior-art references neither describe nor anticipate. Thus, the Independent Claim 95 (and hence, the Dependent Claim 120) should be considered patentable under 35 U.S.C. 103.
45. Applicant submits that in the above-recited frequency to time domain transform module adapted to perform a frequency domain to time domain transform operation on the filtered frequency-domain signal to thereby generate a time-domain signal; and **a decision module for mapping received signal values at points in time to estimated symbol values** in Independent Claim 100 (and hence, in the dependent claim 125) clearly presents novel receiver structure for processing a plurality of carriers that the prior-art references neither describe nor anticipate. Thus, the Independent Claim 100 (and hence, the Dependent Claim 125) should be considered patentable under 35 U.S.C. 103.
46. In particular, the claimed invention in Independent Claims 95 and 100 pertains to a **reception method** and a receiver, whereas Awater shows only a **transmission system**. In a receiver, the steps of performing a frequency domain to time domain transform operation to generate a filtered time-domain signal and **recovering symbols from the filtered time-domain signal** are unique to the present invention because no prior-art multicarrier signaling protocol allows information (i.e., symbols) to be recovered from a time-domain representation of the multicarrier signal. For example, Awater suggests that the corresponding receiver should be a standard

OFDM receiver (col. 4, lines 24-26), which generates a frequency-domain signal, rather than a time-domain signal in order to recover the transmitted information. Thus, the receiver and reception method of the invention provide **new and unexpected results**, making the invention worthy of patent protection. All prior-art multicarrier signals need to be converted to the frequency domain before information can be recovered. Thus, providing for a frequency domain to time domain transformation of a multicarrier signal as a precursor to recovering information in a receiver is **not taught in the prior art**. This is because such processing of prior-art multicarrier signals would result in substantial inter-symbol interference, making symbol recovery difficult or impossible. Similarly, a receiver having a frequency domain to time domain transform followed by a decision module for mapping received signal values at points in time to estimated symbol values is not anticipated by the prior art because such structure would not be practical for receiving prior-art multicarrier waveforms. Accordingly, the claimed invention **solves a new problem never before recognized in the art**. Because the nature of prior-art multicarrier signals makes it impractical to apply Awater's filter block 56 to multicarrier receivers, there is neither teaching nor incentive in the prior art to adapt Awater to resemble the receiver or reception method of the claimed invention. For this reason, the claimed invention **contradicts what is taught in the prior art**. Therefore, there is no prior-art reference, nor combination of prior-art references, that render the claimed invention obvious. Thus, the Independent Claims 95 and 100 (and hence, the Dependent Claims 120 and 125) should be considered patentable under 35 U.S.C. 103.

47. The Independent Claims 110 and 111 (and thus, the corresponding Dependent Claims 135 and 136) should be considered patentable under 35 U.S.C. 103.

48. Applicant submits that the above-recited data source (which is adapted to process a plurality of information symbols to generate a set of data symbols with a predetermined set of phase relationships and amplitude profiles to provide a superposition of the carriers with orthogonality in time) in both Independent

Claims 110 and 111 (and hence, in the Dependent Claims 135 and 136) presents novel structure that the prior-art references neither describe nor anticipate. Thus, the Independent Claims 110 and 111 (and hence, the Dependent Claims 135 and 136) should be considered patentable under 35 U.S.C. 103.

49. The claimed invention produces **new and unexpected results**, making it worthy of patent protection. Specifically, by providing a plurality of data symbols with a predetermined set of phase relationships and amplitude profiles that provide a superposition of the carriers with orthogonality in time, each data symbol is spread over the carriers (thus providing frequency diversity) and the data symbols are mapped onto orthogonal pulse waveforms (thus providing optimal bandwidth efficiency). This results in a multicarrier signal having much better performance in multipath environments compared to prior-art multicarrier signals, such as OFDM. Furthermore, the invention provides a multicarrier signal having a very low Peak-to-Average Power, which **solves an important problem that is well recognized in the prior art**, such as cited in Awater (col. 1, lines 38-42). This problem is solved more effectively (i.e., it provides an optimal combination of Peak-to-Average Power and bandwidth efficiency for a given probability of error) than any prior-art peak-reduction technique, and with less complexity than prior-art techniques, such as Awater's peak-cancellation system. Furthermore, "providing a superposition of the carriers with orthogonality in time," such as recited in Independent Claims 110 and 111, is **taught against by the relevant art** because, unlike in the present invention, the resulting peak-to-average power becomes very high. The present invention generates a sequence, or stream, of pulses that result in a low peak-to-average power, which is truly an **unanticipated and unexpected consequence** because it **contradicts the current teaching in the art**. Also, there is no suggestion in the prior art to combine Awater and Dent in such a way as to produce a superposition of carriers having orthogonality in time. As there is no teaching to change, and no description of how any change may be made to resemble the method and apparatus of the claimed invention, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

50. Section 8 of the Examination Report

Claims 122-124 and 129-131 were rejected under 35 U.S.C. 102(b) as being anticipated by Hamalainen, et. al. (U.S. Pat. No. 5,815,801) in view of Dent, et. al. (U.S. Pat. No. 5,931,893).

51. Claims 122-124 and 129-131 are Dependent Claims of Independent Claims 97-99, and 104-106, respectively. The Independent Claims 97-99 and 104-106 (and thus, the Dependent Claims 122-124 and 129-131) should be considered non-obvious, and thus, patentable under 35 U.S.C. 103.

52. The Independent Claims 97-99 and 104-106 (and thus, the corresponding Dependent Claims 122-124 and 129-131) should be considered patentable under 35 U.S.C. 103.

53. With regard to the amended Independent Claim 97, the steps of providing for selecting a plurality of received **multi-frequency** carriers within a predetermined bandwidth; providing for generating at least one pulse waveform from a superposition of the selected **multi-frequency** carriers clearly presents a novel method and benefits that are non-obvious in view of the prior-art.. Thus, the amended Independent Claim 97 should be considered patentable under 35 U.S.C. 102.

54. With regard to the amended Independent Claim 98, Applicant submits that the above-recited a combiner coupled to the filter, the combiner adapted to combine the received **multi-frequency** carriers to produce at least one signal indicative of a modulated pulse waveform clearly presents novel structure and benefits that are non-obvious in view of the prior-art. Thus, the amended Independent Claim 98 should be considered patentable under 35 U.S.C. 103.

55. With regard to the amended Independent Claim 99, Applicant submits that the above-recited combiner adapted to optimally combine the received **multi-frequency** carriers in the presence of at least one of interference and multipath to generate at least one signal indicative of a modulated pulse waveform clearly presents novel structure and benefits that are non-obvious in view of the prior-art. Thus, the amended Independent Claim 99 should be considered patentable under 35 U.S.C. 103.
56. With regard to the amended Independent Claim 104, the steps of providing for generating at least one pulse waveform from a superposition of the selected **multi-frequency** carriers; and providing for estimating at least one information symbol impressed on the at least one of the pulse waveforms clearly presents a novel method and benefits that are non-obvious in view of the prior-art. Thus, the amended Independent Claim 104 should be considered patentable under 35 U.S.C. 103.
57. With regard to the amended Independent Claim 105, the pulse generator adapted to produce at least one pulse waveform from a superposition of selected **multi-frequency** carriers; and the modulator coupled to the pulse generator, the modulator adapted to accept at least one information symbol and impress the at least one information symbol onto the at least one pulse waveform clearly presents novel structure and benefits that are non-obvious in view of the prior-art. Thus, the amended Independent Claim 105 should be considered patentable under 35 U.S.C. 103.

With regard to the amended Independent Claim 106, the pulse generator adapted to produce at least one pulse waveform having a plurality of **multi-frequency** carrier components; and the modulator coupled to the pulse generator, the modulator adapted to accept at least one information symbol and impress the at least one information symbol on the at least one pulse waveform clearly presents novel structure and benefits that are non-obvious in view of the prior-art. Thus, the amended Independent Claim 106 should be considered patentable under 35 U.S.C. 103.

58. Specifically, the claimed invention combines a plurality of **multi-frequency** carriers to generate pulse waveforms which are then advantageously used to convey information. Applicant's claimed invention produces **new and unexpected results** that make it worthy of patent protection. For example, by generating pulse waveforms in this manner, Applicant's invention enables each data symbol to be spread over multiple carriers, thus providing superior frequency diversity. Furthermore, these pulse waveforms provide orthogonality in time, which enables multiple data symbols and/or users to share the same frequencies, thus providing combined, and typically **contradictory**, benefits of frequency diversity and bandwidth efficiency. This results in a multicarrier signal having much better performance in multipath environments compared to prior-art multicarrier signals, such as OFDM. Furthermore, the invention provides a multicarrier signal having a very low Peak-to-Average Power, which **solves an important problem that is well recognized in the prior art**, such as cited in Awater (col. 1, lines 38-42). This problem is solved more effectively (i.e., it provides an optimal combination of Peak-to-Average Power and bandwidth efficiency for a given probability of error) than any prior-art peak-reduction technique, and with less complexity than prior-art techniques, such as Awater's peak-cancellation system. The present invention achieves these and other notable benefits by **contradicting teachings in the art**. No other prior-art reference deliberately produces pulse waveforms from superpositions of multi-frequency carriers. Such in-phase combining is regarded as undesirable because in-phase combining generally leads to a signal having a high Peak-to-Average Power. Instead, the present invention generates a sequence, or stream, of pulses that each has a *high* Peak-to-Average Power, but together they comprise a signal having a *low* Peak-to-Average Power. This is truly an **unanticipated and unexpected consequence** because it **contradicts the current teaching in the art**. As there is no teaching to change the prior-art references (or any combination of prior-art references), and no description of how any change may be made to resemble the method and apparatus of the claimed invention, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

59. Conclusion

The Applicant submits that every effort has been made to address the Examiner's objections and that the Application is now in condition to proceed to grant.

Yours Respectfully,



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